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Online Tracking as a Mediator in E-Commerce Last-Mile Logistics

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Abstract

Purpose: This study analyzes the factors contributing to customer satisfaction in the context of e-commerce by examining the influence of delivery timeliness and robust detection systems, specifically proposing a mediation model among Shopee users in Indonesia.

Research Methodology: This study employed a quantitative approach, gathering data through an online survey involving 664 respondents. The collected data were then analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with the aid of SmartPLS software.

Results: The findings show that delivery timeliness significantly and positively affects online tracking ($\beta = 0.207$, $t = 5.551$, $p < 0.001$) and customer satisfaction ($\beta = 0.525$, $t = 20.939$, $p < 0.001$).Online tracking also positively affected customer satisfaction ($\beta = 0.439$, $t = 26.538$, $p < 0.001$) and significantly mediated the relationship between delivery timeliness and customer satisfaction (indirect effect = 0.091, $t = 5.600$, $p < 0.001$). The model explains 56.2% of the variance in customer satisfaction ($R^2 = 0.562$).

Conclusions: Timely delivery and online tracking are essential for customer satisfaction. Satisfaction is highest when physical delivery is combined with transparent information.

Limitations: This study focused exclusively on logistics, excluding factors such as price and product quality. Non-probability sampling may limit the generalizability of the study findings.

Contributions: This study contributes to the literature by empirically testing online tracking as a mediator in emerging markets. This study provides managerial implications for e-commerce providers to prioritize investments in real-time tracking infrastructure.

Keywords: *Customer Satisfaction, Delivery Timeliness, E-commerce, Logistics, Online Tracking*

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1. Introduction

The accelerated expansion of Indonesia digital economy has positioned the e-commerce sector as a primary pillar of national economic growth (Anas & Cahyawati, 2023). In this hyper-connected and

increasingly competitive environment, achieving operational efficiency and customer satisfaction is no longer merely a goal but a strategic necessity for business sustainability (Ausat & Prabowo, 2025). Grounded in the principles of operational management, optimizing supply chain processes, particularly the critical aspect of last-mile logistics, is essential for fulfilling consumer expectations (Robbins et al., 2025; Ruminda et al., 2025). Logistics experience in online commerce is a key determinant influencing repurchase intentions and long-term consumer loyalty (Nurmalia et al., 2026; Parlindungan, 2026). While previous studies have predominantly focused on the direct impact of physical delivery speed on customer satisfaction (Harter et al., 2025; Sukayadnya et al., 2026), there is limited understanding of the underlying psychological and informational mechanisms that drive satisfaction during the final delivery phase (Kouas & Akrout, 2025).

Therefore, this study aims to fill this theoretical gap by introducing digital transparency specifically the mediating role of online order tracking as a vital component that bridges physical logistics performance with customer trust and satisfaction in a saturated market (Adeniran et al., 2025; Pramudita & Guslan, 2025; Sitohang & Prasetiyo, 2026). Despite advancements in logistics infrastructure, e-commerce platforms continue to encounter a critical research challenge: frequent mismatches between customer delivery expectations and actual logistics performance(Deshpande & Pendem, 2023). One of the most crucial determinants of mitigating this issue is the timeliness of delivery. Modern e-commerce customers have very high expectations regarding the synchronization between delivery time promises and the actual reality received (Ahmed et al., 2024). A company's inability to meet these time standards creates a perception of service failure. Delivery efficiency is measured not only by speed but also by consistency and the fulfillment of time expectations communicated to the customer (Qu & Wang, 2026; Ruminda, 2026).

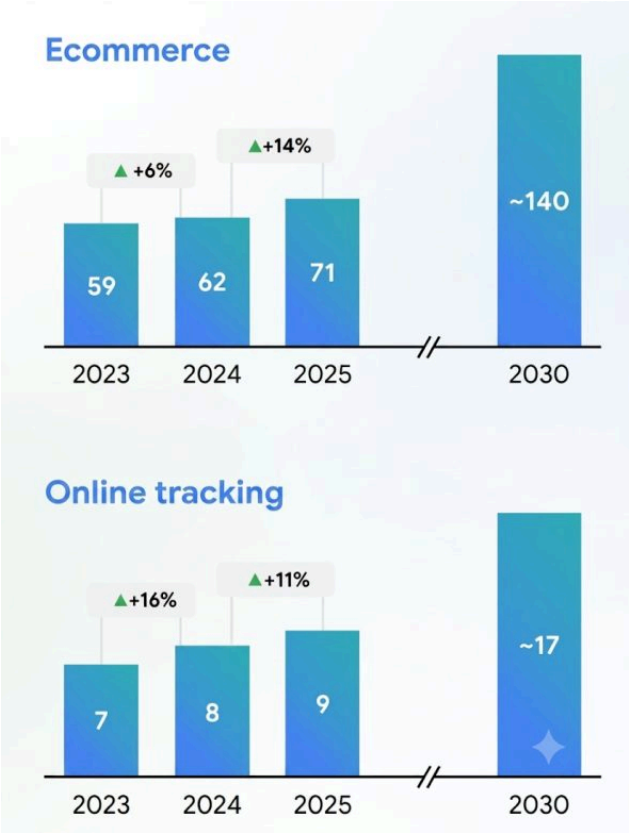


Figure 1. Economic growth in Indonesia

Figure 1 shows the rapid growth of the e-commerce sector in Indonesia, reflecting its increasing contribution to the national digital economy and highlighting its strategic role in driving economic development and business competition. Along with the increasing complexity of distribution, information transparency has become a necessity. In this context, the role of online tracking emerges

as an essential feature that bridges the physical delivery process with the customer's digital experience. Tracking features allow customers to mitigate anxiety during the waiting period by monitoring the position of the goods in real time. Information visibility through tracking systems acts as an instrument of trust that can mitigate negative psychological impacts if minor delivery delays occur (Elmas et al., 2026; Tran, 2025).

Although the direct effect of delivery timeliness on customer satisfaction has been widely examined, a prominent research gap remains regarding the precise mediating role of digital information systems, specifically online tracking, within this dynamic. In contrast to previous research, which tended to be descriptive or focused solely on physical logistics, this study aims to empirically assess whether online tracking mediates the association between delivery timeliness and customer satisfaction among Shopee consumers in Indonesia (Pramudita & Guslan, 2025; Sitompul et al., 2025).

Although prior research has extensively explored the direct effect of delivery timeliness on customer satisfaction, a prominent research gap remains regarding the precise mediating role of digital information systems within this dynamic (Abusalma et al., 2024; Paluzzi et al., 2025). Previous studies on logistics services and customer satisfaction have predominantly treated online tracking as a supplementary technical feature or have focused almost entirely on the physical speed of cargo delivery (Ltifi, 2025; Sitompul et al., 2025). To bridge this research gap, this study investigates the mediating role of online tracking in the relationship between delivery timeliness and customer satisfaction among Shopee users in Indonesia. Employing partial least squares structural equation modeling (PLS-SEM), this study provides a distinct theoretical contribution by positioning real-time tracking transparency not just as an operational tool, but as a critical psychological mechanism that translates physical delivery reliability into cognitive customer trust. Consequently, this study significantly extends the existing logistics management literature and provides targeted managerial recommendations for e-commerce platforms to prioritize investments in information visibility as a strategic driver of competitive advantages.

2. Literature Review and Hypotheses Development

2.1 Customer Satisfaction

Customer satisfaction can be understood as the outcome of a consumer's evaluation of a product or service after use, based on the degree of alignment between the actual quality experienced and the standard of expectations the consumer had established prior to purchase. While early e-commerce literature primarily attributed customer satisfaction to website design and product quality, recent studies have identified a notable theoretical shift (Tripathi et al., 2024; Uvet et al., 2024). Scholars argue that customer satisfaction in online retail is now heavily dictated by functional and physical experiences, particularly during the last-mile order fulfillment stage ((Briana & Malindretos, 2025). This highlights a gap in traditional models, which often overlook logistics as a core component of digital satisfaction. Furthermore, satisfaction is not merely about the physical quality of the product but rather the accumulation of the entire digital and physical interaction process experienced by platform users. Trust within the e-commerce ecosystem is established when service providers consistently achieve transactional satisfaction (Kim & Yum, 2024; Veronica et al., 2025).

2.2 Online Tracking

Online tracking is an information system-based feature that provides real-time visibility and transparency regarding the status and location of goods in transit. Previous literature exhibits diverging perspectives on the role of this feature; early studies predominantly treated tracking as a supplementary technical IT function. Conversely, contemporary research leverages Information Asymmetry Theory to argue that information transparency through tracking systems is a vital tool for mitigating risk and uncertainty in the supply chain (Bi et al., 2024; Pietrzak et al., 2024). Addressing this theoretical divergence, the mechanism within this mediation model conceptualizes online tracking not only as technical data provision but also as a psychological catalyst. By reducing information asymmetry, this visibility creates psychological comfort for customers, allowing them to independently monitor whether the delivery is proceeding according to schedule(Dong et al., 2024; Lambillotte et al., 2022). Thus, the theoretical mechanism posits that the effectiveness of

online tracking strengthens the positive cognitive impact of timeliness on overall customer satisfaction.

2.3 Timeliness of Delivery

Timeliness of delivery can be defined as the capacity of a logistics service provider to ensure that goods reach customers within the timeframe agreed upon or promised at the outset of the transaction. A review of previous research reveals an ongoing theoretical inconsistency regarding logistics priorities: while some scholars assert that absolute delivery speed is the primary driver of satisfaction, other studies demonstrate that consistency in delivery time is valued much more highly by consumers (Kaleeswaran et al., 2026). Customers rely on delivery time reliability to make careful personal plans, making it a highly significant correlate of long-term loyalty. Delivery delays are a primary source of service failure that can drastically reduce customer trust in a platform (Mao et al., 2025; Sirait, Sitorus, et al., 2026; Tong et al., 2026). By focusing specifically on timeliness (consistency) rather than mere physical speed, this aspect is positioned as a vital component of last-mile logistics service quality.

2.4 Hypotheses Development

2.4.1 The Effect of Delivery Timeliness on Online Tracking

Timeliness in the delivery process extends beyond the final result received by the consumer; it reflects how the entire process is systematically managed through solid operational data integration (Masa'deh et al., 2022; Rasyid et al., 2026). In the field of Information Systems, achieving operational efficiency in physical supply chain management is a foundational requirement that must be met before a digital information visibility system can function with an adequate level of accuracy (Ali et al., 2024; Ruminda, 2025). When physical deliveries proceed according to a highly disciplined and regular schedule, the input of milestone data becomes stable and synchronized. Consequently, this physical consistency enables the tracking system to generate and provide reliable real-time data to platform users without latency or error (Mütze et al., 2024). Based on the theoretical framework presented, the following hypothesis is proposed:

H_1: Delivery timeliness positively affects online tracking

2.4.2 The Effect of Delivery Timeliness on Customer Satisfaction

In the online shopping ecosystem, fulfilling delivery time promises is a critical key performance indicator whose impact is directly and cognitively evaluated by consumers (Akturk et al., 2022; Masuch et al., 2024). Grounded in Expectancy-Confirmation Theory (ECT), consumer satisfaction is heavily dependent on whether the actual service execution meets or exceeds their initial expectations regarding the promised Estimated Time of Arrival (ETA) (Zhao & Gilbert, 2025). Timeliness in last-mile delivery is often the decisive determinant of whether customers feel functionally satisfied and are ultimately willing to make repeat purchases, as speed and delivery precision create a high convenience value that reduces consumer effort (Harter et al., 2025; Paluzzi et al., 2025). Based on the theoretical framework presented, the hypothesis below is put forward:

H_2: Timeliness of delivery positively affects customer satisfaction

2.4.3 The Effect of Online Tracking on Customer Satisfaction

The availability of transparent information regarding the position of goods provides customers with a sense of psychological control over their financial transactions (Attaoui & Gaber, 2026). Drawing on Uncertainty Reduction Theory, the primary function of the tracking feature is to proactively mitigate consumer anxiety and perceived risk during the post-purchase waiting period (Niyompuhwe & Kumar, 2025; Puengwattanapong & Leelasantitham, 2022). Easy and accurate data accessibility demonstrates operational transparency, which theoretically strengthens the perception of the service provider's professionalism and significantly boosts emotional satisfaction with the e-commerce platform (Attaoui & Gaber, 2026; Hwang et al., 2024). Based on the theoretical framework presented, the following hypothesis is proposed:

H₃: Online tracking positively affects customer satisfaction

2.4.4 The Mediating Role of Online Tracking

To address the complexity of modern consumer behavior, this study conceptualizes online tracking as a strategic psychological bridge connecting operational delivery performance and cognitive customer perceptions (Hwang et al., 2024). While timely delivery is physically essential, its value may not be fully appreciated if consumers remain anxious during transit. Online tracking acts as an active cognitive mediator, allowing customers to independently and continuously validate that on-the-ground delivery performance aligns with promised standards (Nexhipi & Gjoni, 2022). This successful integration of digital information systems acts as a psychological catalyst, clarifying the benefits of timely physical delivery and transforming operational reliability into concrete user trust and satisfaction (Abdulmuhsin et al., 2025; Seo & Roh, 2025). Therefore, the following hypothesis is proposed:

H₄: Online tracking mediates the relationship between delivery timeliness and customer satisfaction

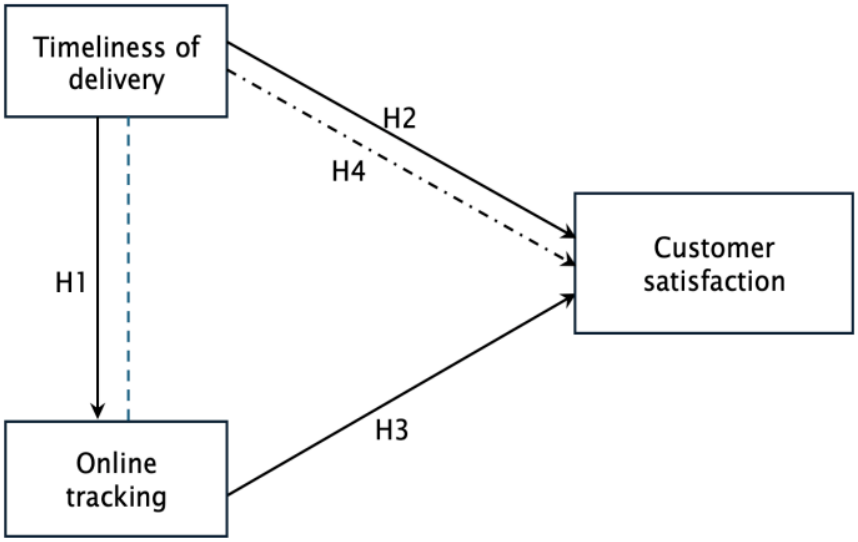


Figure 2. Research framework

Figure 2 shows the conceptual framework of this study. The framework proposes that the timeliness of delivery has a direct effect on online tracking and customer satisfaction. Moreover, online tracking is expected to positively affect customer satisfaction and serve as a mediator between delivery timeliness and customer satisfaction. Based on this conceptual framework, four hypotheses (*H1–H4*) were proposed to assess the direct and indirect relationships among the research variables.

3. Research Methodology

This study used a quantitative approach with an explanatory research design to test and clarify the causal relationships among the variables under investigation. Specifically, this survey-based study investigates the role of Online Tracking (OnT) as a mediating variable that bridges the link between Delivery Timeliness (Del) and Customer Satisfaction (Sat). Given that this study involves evaluating user perceptions of a digital service embedded within a physical supply chain process, an online questionnaire was deemed the most appropriate data collection method.

3.1 Population and Sampling

The population of this study consisted of consumers who purchased products through the Shopee Indonesia platform and utilized its order-tracking feature. Because the exact population size is unknown and the users are geographically vast, the sampling technique applied in this research is non-probability sampling, employing the purposive sampling method. The sample criteria required respondents to meet the following specific conditions: having successfully completed a transaction on

Shopee within the last three months to ensure recall accuracy; residing in Indonesia; and having direct experience actively monitoring their package using the in-app order tracking feature.

The online questionnaire was distributed electronically via social media channels and online community forums over a two-month period. Based on these strict criteria, 664 valid respondents were obtained. Demographically, the sample predominantly consisted of women (58.43%), indicating a higher engagement rate among women in online shopping within this cohort. Furthermore, most respondents (39.76%) fell within the productive age group of 29–33 years. When combined with the adjacent age brackets, over 78% of the respondents were aged between 24 and 38 years, reflecting a highly digitally literate young adult demographic that actively engages with the features of e-commerce logistics.

3.2 Measurement and Instrument

To obtain an accurate representation of respondents' perceptions, the questionnaire instrument in this study was constructed based on established theoretical constructs, which were subsequently adapted to align with the context of e-commerce last-mile logistics. All variables were subsequently measured using a five-point Likert scale, with scores ranging from 1, denoting "Strongly Disagree," to 5, denoting "Strongly Agree". Timeliness of Delivery (Del) was operationalized using five indicators (Del1 to Del5). These items measured the alignment of actual arrival with initial time estimates, speed of the transit process, proactive communication regarding delays, and overall consistency of arrival schedules (Qu & Wang, 2026).Online Tracking (OnT) was measured using four indicators (OnT1 to OnT4). This construct evaluated the real-time data accessibility, precision and accuracy of the reported position of the goods, ease of using the tracking interface, and overall reliability of the status information provided.Customer Satisfaction (Sat) was assessed using four indicators (Sat1 to Sat4). These items captured the fulfillment of post-transaction expectations, satisfaction with logistics service convenience, likelihood of recommending the service, and intention to repurchase based on the delivery experience (Thuy et al., 2026).

3.3 Common Method Bias Testing

Given that data pertaining to both the independent and dependent variables were obtained simultaneously from the same set of respondents through a single self-report questionnaire, the possibility of Common Method Bias (CMB) cannot be ruled out. To minimize this risk, procedural safeguards were embedded into the questionnaire design process, such as preserving respondent anonymity and randomizing the sequence of items to reduce the likelihood of patterned responses. Beyond these measures, a subsequent statistical evaluation was performed using Harman's single-factor test (Aguirre-Urreta & Hu, 2019; Howard et al., 2024; Saxena et al., 2024). Results from the unrotated principal component analysis indicated that the proportion of total variance explained by the largest single factor remained under 50%, with the first factor's value situated considerably below the established critical threshold. This outcome provides statistical evidence that Common Method Bias does not pose a meaningful threat to the validity of the data or the accuracy of the structural model estimations conducted in this study.

3.4 Data Analysis

To examine the collected data, this study employed the partial least squares structural equation modeling (PLS-SEM) approach as its primary analytical technique. The primary software used to compute the statistical data was SmartPLS (version 4). This study's analytical procedure consisted of two principal stages: Measurement Model Evaluation (Outer Model), aimed at testing convergent validity based on Outer Loading and Average Variance Extracted (AVE) values, assessing discriminant validity through the Heterotrait-Monotrait Ratio (HTMT), and evaluating construct reliability using Cronbach's Alpha and Composite Reliability indices. Structural Model Evaluation (Inner Model): This stage assessed the model's strength through R-squared values, the extent of variable contribution via f-square, and predictive relevance through Q-squares (Cheah et al., 2024; Hair & Alamer, 2022).

4. Results and Discussions

4.1 Respondent Demographic Profile

This study involved 664 respondents who had made purchases from online stores in Indonesia within the last three months prior to the study. The characteristics of the respondents showed a predominance of females, accounting for 388 respondents (58.43%), while males accounted for 276 respondents (41.57%). There was a 16.86% difference between female and male respondents, indicating that online stores were more frequently accessed by female consumers. Regarding age, most respondents belonged to the productive age group of 29–33 years (39.76%). Combined with the wider 24–38 age range, this segment accounted for over 78% of the entire study sample.

Overall, the primary profile of online store customers in this study was young adult females. These data suggest that marketing strategies and logistics service improvements would be highly effective if targeted at this specific demographic (Hasibuan et al., 2026; Shukla et al., 2022). Conversely, the market segment for those over the age of 44 remains very small, which may be attributed to differences in shopping behavior or limited technological adoption among that age group.

4.2 Descriptive Statistics and Normality Testing

According to the descriptive statistical analysis, the mean values across all indicators ranged between 3.94 and 4.60, suggesting that the respondents generally provided positive responses to the statements presented. Indicator Del5 recorded the highest mean (4.6069), whereas OnT3 showed the lowest value (3.9428). Overall, the Delivery Timeliness (Del) variable recorded the highest mean score compared to Online Tracking (OnT) and Customer Satisfaction (Sat), indicating that the respondents perceived the physical delivery performance as excellent.

Table 1. Descriptive statistics and normality testing

Construct	Item	Mean	Std	Normality Test	
				Excess kurtosis	Skewness
OnT	OnT1	4.0693	1.1359	1.3520	-1.4090
	OnT2	4.0377	1.0783	0.7861	-1.0790
	OnT3	3.9428	1.0809	-0.5100	-0.6175
	OnT4	3.9488	1.0798	0.4769	-0.9842
Del	Del1	4.3614	0.9673	0.7487	-1.3760
	Del2	4.3720	1.0173	0.8348	-1.4224
	Del3	4.4277	0.9944	1.5517	-1.6280
	Del4	4.5617	0.7619	3.0541	-1.8780
	Del5	4.6069	0.7449	2.8885	-1.9147
Sat	Sat1	4.0738	0.7212	1.4551	-0.8600
	Sat2	4.1476	0.7540	1.8677	-1.0115
	Sat3	4.1717	0.7327	1.1440	-0.8557
	Sat4	4.2334	0.6686	2.7705	-1.0369

Table 1 shows that normality testing reveals that the skewness values fall within the range of -0.61 to -1.91, which satisfies the normality criteria for PLS-SEM analysis. Furthermore, the excess kurtosis values were within acceptable limits. Although the data exhibit a relatively strong negative skewness on items Del4 and Del5 (approaching -2), the data are statistically robust for further structural analysis as the values do not exceed extreme thresholds.

4.3 Measurement Model Evaluation (Outer Model)

4.3.1 Outer Loading and AVE

The outer model in this study was evaluated by conducting validity and reliability tests. All research indicators (Del1-Del5, OnT1-OnT4, Sat1-Sat4) exhibited outer loading values above 0.7316, all obtained values surpassed the recommended minimum threshold of 0.70, while the Average Variance Extracted (AVE) values for each construct were recorded above 0.50. (Del: 0.7699; OnT: 0.7783; Sat: 0.7980).

Based on Figure 3, all indicators of the Del, OnTl, and Sat constructs exhibited loading factor values above 0.70, ranging from 0.7316 to 0.9404. Furthermore, the AVE values for Del, OnTl, and Sat were 0.7699, 0.7783, and 0.7980, respectively, all exceeding the recommended threshold of 0.50. These results indicate that all indicators adequately represent their respective constructs, confirming that the measurement model satisfies the convergent validity criteria.

4.3.2 Reliability and Convergent Validity

Regarding reliability, all constructs recorded Cronbach's alpha, rho_a, and rho_c values exceeding 0.90, indicating an exceptionally high level of internal consistency across the measurement items.

Table 2. Outer loading, construct reliability, and validity

Construct	Item	Outer loading	Cronbach alpha	rho_a	rho_c	AVE
Del	Del1	0.7316	0.9266	0.9555	0.9432	0.7699
	Del2	0.9120				
	Del3	0.9404				
	Del4	0.9289				
	Del5	0.8575				
OnT	OnT1	0.8137	0.9049	0.9391	0.9334	0.7783
	OnT2	0.8755				
	OnT3	0.8983				
	OnT4	0.9369				
Sat	Sat1	0.9261	0.9155	0.9234	0.9404	0.7980
	Sat2	0.9018				
	Sat3	0.8448				
	Sat4	0.8986				

Table 2 shows that all indicators exhibit outer loading values above the recommended 0.70 threshold, ranging from 0.7316 to 0.9404, thus demonstrating adequate indicator reliability. In addition, the Cronbach's alpha values for Del, OnT, and Sat were 0.9266, 0.9049, and 0.9155, respectively, all of which were above the acceptable threshold of 0.70. The rho_A and composite reliability (rho_C) values were above 0.70, indicating good internal consistency. VE values between 0.7699 and 0.7980 provide additional evidence of satisfactory convergent validity, as they exceed the recommended minimum of 0.50. Based on these combined results, the measurement model demonstrated sufficient reliability and validity, confirming its appropriateness for progressing to the subsequent structural model analysis.

4.3.3 Discriminant Validity – HTMT

The results of the Heterotrait-Monotrait Ratio (HTMT) test reveal that the values for all construct pairs fall below the stringent threshold of 0.85, confirming discriminant validity.

Table 3. Discriminant validity: Heterotrait-Monotrait Ratio (HTMT)

Construct	Del	OnT	Sat
Del			
OnT	0.2002		
Sat	0.6161	0.5839	

Table 3 presents the results of the discriminant validity assessment based on the Heterotrait-Monotrait Ratio (HTMT) criterion. The HTMT values between Del and OnT, Del and Sat, and OnT and Sat are 0.2002, 0.6161, and 0.5839, respectively. Every recorded value fell below the recommended maximum threshold of 0.85, confirming that each construct was empirically distinct from one another. Consequently, the measurement model exhibited adequate discriminant validity. This proves that each variable is unique and distinct. Respondents were able to distinguish between the concepts of delivery timeliness, online tracking, and customer satisfaction.

4.4 Structural Model Evaluation

4.4.1 Collinearity Statistics – VIF

To ensure that the model was free from multicollinearity issues, the Variance Inflation Factor (VIF) was assessed. The results of the VIF analysis are shown in Table 4.

Table 4. Collinearity statistics: Variance Inflation Factor (VIF)

Construct	OnT	Sat
Del	1	1.0439
OnT		1.0439

Table 4 shows that the Variance Inflation Factor (VIF) among the predictor variables was recorded at 1.0439, a value considerably lower than the recommended threshold of 3.0. This finding indicates that multicollinearity is not a meaningful concern in the proposed model. Consequently, it can be concluded that Del and OnT independently contribute to the explanation of the Sat.

4.4.2 R-Square Test

The explanatory strength of the structural model was assessed using the coefficient of determination (R^2), the results of which for each endogenous construct are detailed in Table 5.

Table 5. R-square test

	R-square	Remark
OnT	0.0421	Weak
Sat	0.5621	Moderate

As shown in Table 5, the structural strength of the model was assessed using R-squared and f-square testing. The resulting R-square value for the OnT variable was 0.0421, indicating that Delivery Timeliness explains only 4.21% of the total variance observed in the Online Tracking. From a theoretical and operational logistics perspective, this relatively low R^2 is justifiable and expected. In the e-commerce ecosystem, online tracking is an Information Technology (IT) artifact, whereas delivery timeliness is a physical logistics outcome. The quality, accuracy, and real-time nature of the tracking features are predominantly dictated by technological and infrastructural factors (accounting for the remaining 95.79% of the variance). These unobserved factors include digital interoperability and Application Programming Interface (API) synchronization between the e-commerce platform and third-party logistics (3PL) providers, courier discipline in scanning package barcodes at each physical milestone, and geographical constraints that affect Internet or GPS connectivity.

Conversely, the R-squared value for the Sat variable shows that Delivery Timeliness and Online Tracking collectively account for a robust 56.21% of the variance in customer satisfaction. In behavioral and business research, an R^2 value exceeding 50% denotes moderate-to-substantial predictive power. This confirms that the combination of physical delivery performance and digital tracking transparency plays a dominant role in shaping overall customer satisfaction in e-commerce, while the remaining 43.79% is likely influenced by product quality, pricing strategies and platform interface design.

4.4.3 f-Square Test

Based on the F-square test, the Del variable exerted a large effect (0.6030) on satisfaction, whereas its effect on online tracking was considered small (0.0439).

Table 6. f-square test

Construct	OnT	Sat
Del	0.0439	0.6030
OnT		0.4201

Table 6 shows the effect sizes (f^2) of each structural relationship. Del had a large effect on Sat (f^2 = 0.6030), indicating that delivery performance is a major determinant of customer satisfaction. In contrast, the effect of Del on OnT was relatively small (f^2 = 0.0439). Furthermore, OnT exhibited a moderate effect on Sat (f^2 = 0.4201), suggesting that online tracking contributes meaningfully to customer satisfaction.

4.4.4 Blindfolding Test

The predictive relevance of the model was confirmed using the Q2 value (blindfolding test). The Q2 value for customer satisfaction was 0.4410 (large predictive relevance).

Table 7. Blindfolding test

Q^2 (=1-SSE/SSO)	
Del	0.0000
OnT	0.0283
Sat	0.4410

As presented in Table 7, the Q^2 values recorded for OnT and Sat were 0.0283 and 0.4410, respectively. Given that both values exceed zero, it can be concluded that the model exhibits predictive relevance with respect to the endogenous constructs examined. Additionally, the comparatively higher Q^2 value observed for Sat indicates that the model possesses a greater predictive capability for customer satisfaction relative to online tracking. To visually represent the outcomes of the blindfolding procedure, the predictive relevance model is shown in Figure 4.

Figure 4 illustrates the blindfolding model and confirms the predictive relevance of the proposed structural model. The results indicate that the model has greater predictive accuracy for Satisfaction than for Online Tracking, as reflected by the higher Q^2 value of the satisfaction construct.

4.5 Hypotheses Testing

The significance of the relationships among Delivery (Del), Online Tracking (OnT), and Satisfaction (Sat) was assessed using the bootstrapping technique. The resulting path coefficients, t-statistics, and coefficients of determination (R^2) are shown in Figure 5.

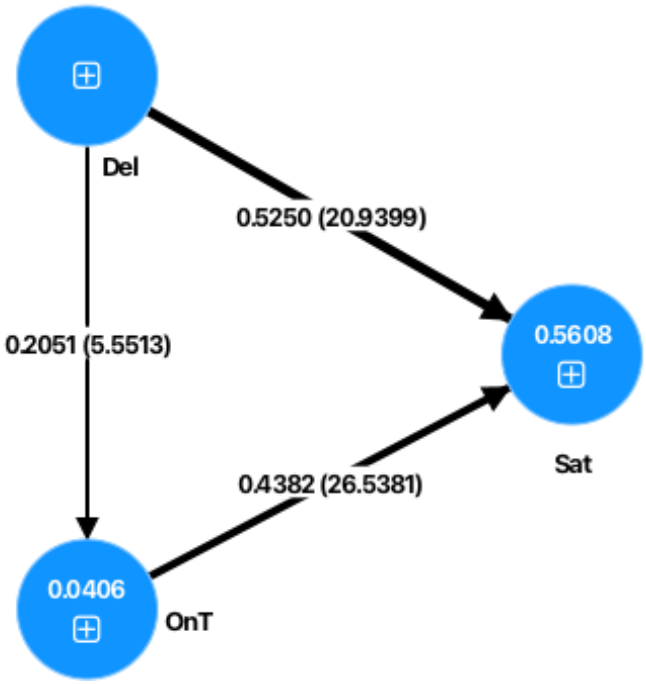


Figure 5. Bootstrapping model

Figure 5 shows the results of the structural model bootstrapping. The path coefficients indicate that Del positively affects OnT (β = 0.2051) and Sat (β = 0.5250), whereas OnT also has a positive effect on Sat (β = 0.4382). In addition, the model explained 4.06% of the variance in OnT (R^2 = 0.0406) and 56.08% of the variance in Sat (R^2 = 0.5608).The significance of the direct and indirect relationships among the constructs was assessed using bootstrapping. The results of the hypothesis testing are presented in Table 8.

Table 8. Hypotheses test

Hypotheses	Path	Std. Beta	Std Error	t value	p value	Bias	Confidence interval		Remarks
							2.50%	97.50%	
H_1	Del → OnT	0.2070	0.0369	5.5513	0.0000	0.0019	0.1324	0.2786	Accepted
H_2	Del → Sat	0.5249	0.0251	20.9399	0.0000	-0.0001	0.4709	0.5710	Accepted
H_3	OnT → Sat	0.4391	0.0165	26.5381	0.0000	0.0009	0.4064	0.4709	Accepted
H_4	Del → OnT → Sat	0.0908	0.0160	5.6008	0.0000	0.0009	0.0587	0.1214	Accepted
Note: p-value 0.05 dan t-value 1.96									

As reported in Table 8 , the empirical results support all four hypotheses. The analysis shows that Delivery (Del) has a statistically significant positive association with Online Trust (OnT) (β = 0.2070, t = 5.5513, p < 0.001), thus confirming H_1. Delivery also had a significant positive effect on satisfaction (Sat) (β = 0.5249, t = 20.9399, p < 0.001), supporting H2. In addition, Online Trust was found to positively and significantly contribute to satisfaction (β = 0.4391, t = 26.5381, p < 0.001), which supports H3. The indirect effect analysis further indicates that Online Trust significantly mediates the association between Delivery and Satisfaction (β = 0.0908, t = 5.6008, p < 0.001), confirming H4. Moreover, the confidence intervals associated with all structural paths remained above or below zero, reinforcing the statistical significance of the relationships examined.

4.6 Discussions

4.6.1 The Relationship between Delivery Timeliness and Online Tracking

The findings demonstrate that Delivery Timeliness significantly and positively influences Online Tracking (β = 0.207; p < 0.001). This finding supports H1 and demonstrates that physical reliability in logistics serves as the foundational trigger for digital tracking systems(Nagadeepa et al., 2024). Theoretically, when a physical delivery process is managed with strict scheduling, the milestone data inputted into the digital system become synchronized (Chen et al., 2025; Kurniawan & Alamsjah, 2025). However, as evidenced by the low R^2 value (4.21%), physical timeliness is a necessary but insufficient condition for tracking excellence. The digital manifestation of the tracking status relies heavily on external IT infrastructure, such as 3PL server responsiveness and courier compliance in data entry (Eskandarzadeh et al., 2023; Ruthramathi & Sivakumar, 2025). Thus, while an on-time package triggers timely system updates, the ultimate quality of the tracking feature is largely governed by the platform's technological interoperability (Kant, 2025; Silalahi et al., 2025).

4.6.2 The Relationship between Delivery Timeliness and Customer Satisfaction

The second hypothesis (H_2) demonstrated the strongest direct influence in this study (β = 0.525; p < 0.001). Grounded in Expectancy-Confirmation Theory, this result implies that for e-commerce users, fulfilling the promised Estimated Time of Arrival (ETA) is the primary baseline for satisfaction (Almutairi et al., 2026; Arum & Prasetiyo, 2026). Speed, accompanied by schedule precision, creates a high functional convenience value that directly translates to a positive cognitive evaluation (Bhatt & Khokhar, 2020). In a saturated digital market, last-mile delivery efficiency remains the most critical physical determinant affecting consumers' overall assessment of e-retailer service quality (Aljohani, 2024; Ocak, 2025).

4.6.3 The Relationship between Online Tracking and Customer Satisfaction

The results confirm that Online Tracking significantly impacts Customer Satisfaction (β = 0.439; p < 0.001), supporting H_3. From the perspective of Uncertainty Reduction Theory, the transparency provided by real-time tracking acts as a vital psychological instrument (Haseeb et al., 2021; Liu et al., 2025). It mitigates consumer anxiety and perceived risk during the post-purchase waiting period by

providing a continuous flow of information (Linh & Park, 2025). The ability to seamlessly monitor order movements has shifted from being perceived as an added value to a basic service standard, one that theoretically validates the platform's reliability and professionalism in the eyes of modern consumers (Akturk et al., 2022; Fatorachian & Pawar, 2025).

4.6.4 The Mediating Role of Online Tracking

The mediation test validates that Online Tracking significantly bridges the relationship between Delivery Timeliness and Customer Satisfaction (indirect effect = 0.090; p-value < 0.05), fully supporting H4. This is a critical finding, indicating that the positive impact of fast and timely delivery is significantly amplified when customers can independently verify the process through their digital screens (Ruminda, 2025; Wang et al., 2025). The tracking feature successfully clarifies the benefits of a strong physical logistics performance. Consequently, online tracking should be viewed not merely as an IT feature but as a strategic mediator that translates operational excellence into tangible customer trust and satisfaction (Helo & Thai, 2024; Sianturi et al., 2024; Sirait, Lermatan, et al., 2026).This finding enriches the literature by merging logistics service quality with digital metrics. This confirms that in modern e-commerce, the physical movement of goods (logistics) and the digital flow of data (online tracking) cannot be treated in isolation; the digital service acts as an essential catalyst that actualizes the value of physical logistics in the consumer's mind (Adeniran et al., 2025; Li & Nichols, 2026).

5. Conclusions

5.1 Conclusion

Based on the quantitative analysis of Shopee platform users in Indonesia, this study successfully validated the critical role of last-mile logistics in shaping customer satisfaction. All proposed hypotheses were fully supported. Delivery timeliness directly and significantly drives customer satisfaction. Fulfilling promised arrival estimates serves as a key performance indicator that prevents perceived service failures. Furthermore, the availability of a reliable online tracking feature is essential, as it provides consumers with psychological control, mitigates transit anxiety, and elevates the perceived professionalism of the service provider.

This study strengthens the theoretical intersection between logistics and digital services literature. Traditionally, logistics literature has emphasized physical efficiency (delivery speed and timeliness), whereas digital service literature has focused on system quality and information transparency. This study contributes to the literature by empirically demonstrating that these two domains are inherently interdependent in the e-commerce context. Online tracking acts as a critical psychological mediator a digital bridge that translates physical logistics performance into cognitive trust. This proves that physical delivery reliability achieves maximum customer satisfaction only when it is harmoniously integrated with real-time digital visibility, thereby extending e-service quality theories into a cyber-physical logistics framework.

The findings provide clear guidance for e-commerce platforms and Third-Party Logistics (3PL) providers. Management must prioritize investments in real-time tracking infrastructure and ensure strict synchronization with the physical supply chain operations. Transparent information should be strategically leveraged as an instrument of trust to proactively manage customer expectations, especially when operational delays occur.

5.2 Research Limitations

While this study provides valuable insights into e-commerce last-mile logistics, several limitations should be acknowledged. First, the research scope is restricted exclusively to logistics-centric variables, namely delivery timeliness and online tracking, leaving other critical determinants of customer satisfaction, such as pricing strategies, product quality, customer service, and user interface design, unexamined. Second, the use of a non-probability purposive sampling technique inherently restricts the extent to which the empirical findings can be generalized to the wider consumer population in Indonesia. Finally, the data collection is solely confined to Shopee users, thereby preventing a cross-platform comparative analysis that could capture distinct technological features

and consumer dynamics inherent in other major e-commerce platforms such as Tokopedia, Lazada, and TikTok Shop.

5.3 Suggestions and Directions for Future Research

Drawing on the empirical findings and limitations noted above, several strategic recommendations are proposed to guide future research. First, future studies should expand the analytical scope by incorporating determinants of customer satisfaction that lie outside the realm of logistics management, such as pricing strategies, product quality, customer service responsiveness, and user interface design. Second, to enhance the generalizability of the results to a broader macro consumer population, subsequent research should employ probability sampling techniques to achieve a more equitable geographical and demographic distribution of respondents across regions. Finally, future researchers are strongly encouraged to conduct cross-platform comparative analyses within the e-commerce sector (comparing Shopee with other major marketplaces such as Tokopedia, Lazada, or TikTok Shop) to assess whether significant differences exist in the effectiveness of online tracking systems and the dynamics of consumer behavioral adaptation across distinct platform ecosystems.

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Author Contributions

MR conceptualized the study, conducted the research, analyzed the data, and wrote the manuscript. SW supervised the research process, provided methodological guidance and reviewed the manuscript. DD was responsible for data collection, analysis, and interpretation of the findings. VV conducted the literature review, supported the interpretation of the results, and participated in editing the manuscript. PCS provided critical revisions, validated the research findings, and ensured the manuscript's overall quality and compliance with publication standards.

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